Below are suggestions of projects. You also have the option to choose your own project, but please have it approved by the instructor if you do. After teams have been formed, please notify me with your choice of project (hillk@umn.edu), indicating a first and second choice in case another team has already chosen your first choice.

Project Casino

Choose one or two of the games below and simulate them using Monte Carlo simulation. Use standard rules for each game.

1. **Blackjack**
   What makes Blackjack exciting in a casino is that the dealer's original two cards are one up, one down, so you do not know the dealer's total and must play the odds based on the one card showing. You do not need to incorporate this twist into your simulation. Here's what you *are* required to do: run through 12 sets of 2 decks playing the game. You have an unlimited bank, and bet 2 on each hand. Each time the 2 decks run out, the hand in play continues with 2 fresh decks. At that point, record your standing, in dollars, and start at 0 again for the next deck. You can average the 12 results from playing each of the 12 sets of decks to determine your total overall performance. Your strategy will be up to you, but you will assume that you can see neither of the dealer's cards. Choose a strategy to play, and then play it throughout the entire simulation.

2. **Craps**
   We will play by the rule that on an initial roll of 12, both pass and don't pass bets are losers. Both are even-money bets. Estimate the probability of winning a pass bets and the probability of winning a don't pass bet. Which is the better bet? As the number of trials increases, to what do the probabilities converge?

3. **Roulette**
   Play by American Roulette rules. Simulate playing $1,000$ games, betting either red or black. Bet 1 on each game and keep track of your earnings. What are the earnings per game betting red/black according to your simulation? What was your longest winning streak? Longest losing streak? Then simulate $1,000$ games betting green. How do your earnings per game differ from your earnings betting red/black? What strategy do you recommend using, and why?

Project Risk

Suppose that the different policyholders of a casualty insurance company generate claims according to a Poisson process with a common rate λ, and that each claim amount has distribution F. Suppose also that new customers sign up according to a Poisson process with rate ν, and that each existing policyholder remains with the company for an exponentially distributed time with rate μ. Finally, suppose that each policyholder pays the insurance firm at a fixed rate per unit time. Starting with n_0 customers and initial capital $a_0 \geq 0$, use simulation to estimate the probability that the firm's capital is always nonnegative at all times up to time T.

Project Mail

Messages arrive at a communications facility in accordance with a Poisson process having a rate of 2/hour. The facility consists of three channels, and an arriving message will either go to a free channel if any of them are free or else will be lost if all channels are busy. The amount of time that a message ties up a channel is a random variable that depends on the weather condition at the time the message arrives. When the weather is "good" when the message arrives, the processing time has the distribution function

$$F(x) = x, \quad 0 < x < 1,$$

whereas if the weather is "bad" when a message arrives, then its processing time has the distribution function

$$F(x) = x^3, \quad 0 < x < 1$$

Determine some cases for weather patterns, and model the wait time. Estimate the mean number of lost messages in the first 100 hours of operation.

Project Baseball

Construct a Monte Carlo simulation of a baseball game. Use individual batting statistics between to of your favorite teams to simulate the probability of a single, double, triple, home run, or an out. Suggestions on further analysis may be to consider how to handle walks, hit batters, steals, and double plays.

Project Rush Hour

This project investigates the idea of multiple-server queues. Consider an office building with 12 floors in downtown Minneapolis. During the morning rush hour, from 7:50 am to 9:10 am, workers enter the lobby of the building and take one of the four elevators to their floor. The time between arrivals of the customers at the building varies in a probabilistic manner every 0-30 sec, and on arrival each worker selects the first available elevator. When the worker enters an elevator and selects a floor, the elevator waits 15 sec before closing its doors. If another person arrives within the 15-sec interval, the waiting cycle is repeated. If no person arrives within the 15-sec interval, the elevator departs to deliver all of its passengers. As people arrive in the lobby and no elevator is available, a queue begins to form in the lobby.

Some workers are complaining that they spend too much time riding the elevator, and other complain that there is considerable congestion in the lobby during the morning rush hour. What is the real situation? Can management resolve the complains my more effectively scheduling or using the elevators? Some questions to consider are the length of the longest queue, the average waiting time of a person in the queue, the delivery time (the time it takes a worker to reach his or her floor after arriving in the lobby), and the average and maximum time a worker spends in the elevator.